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DOI: <https://doi.org/10.1007/s00787-011-0232-y>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-156020>

Journal Article

Published Version

Originally published at:

Hepp, Urs; Stulz, Niklaus; Unger-Köppel, Jürg; Ajdacic-Gross, Vladeta (2012). Methods of suicide used by children and adolescents. *European Child Adolescent Psychiatry*, 21(2):67-73.

DOI: <https://doi.org/10.1007/s00787-011-0232-y>

Methods of suicide used by children and adolescents

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Received: 11 May 2011 / Accepted: 12 November 2011 / Published online: 1 December 2011
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Abstract Although relatively rare, suicide is a leading cause of death in children and adolescents in the Western world. This study examined whether children and adolescents are drawn to other methods of suicide than adults. Swiss suicides from 1998 to 2007 were examined. The main methods of suicide were analysed with respect to age and gender. Of the 12,226 suicides which took place in this 10-year period, 333 were committed by children and adolescents (226 males, 107 females). The most prevalent methods of suicide in children and adolescents 0–19 years were hanging, jumping from heights and railway-suicides (both genders), intoxication (females) and firearms (males). Compared to adults, railway-suicides were over-represented in young males and females (both $P < .001$). Jumping from heights was over-represented in young males ($P < .001$). Thus, availability has an important effect on methods of suicide chosen by children and adolescents. Restricting access to most favoured methods of suicide might be an important strategy in suicide prevention.

Keywords Suicide · Prevention · Firearms · Asphyxia · Poisoning · Anti-depressive agents · Legislation

Introduction

In Europe, suicide is the second leading cause of death in the age group 15–29 years [4]. As in other European countries, suicide rates in Switzerland have declined over the past two decades [17]. The Swiss suicide rate peaked in the late 1970s and early 1980s at about 25 per 100,000 and fell to about 17 per 100,000 by the late 1990s. This general trend was not reflected equally in all methods of suicide [14]; for example, rates of firearm suicides declined but with a marked delay.

The availability of lethal methods has an important impact on the method of suicide used [6, 7, 10, 19]. The restriction of the availability of lethal methods is an important approach to suicide prevention [18]. There are gender and age-specific differences in the methods of suicide used [32, 33]. Children and adolescents may be attracted by different means of suicide and may not have the same access to lethal methods as adults. A better understanding of the suicidal behaviour of children and adolescents is imperative for developing an adequate preventive approach aimed at this age group.

The aim of this study was to analyse suicides in Switzerland over a period of 10 years in the age group 0–19 years compared to the age group over 19 years with regard to gender and different methods of suicide.

Data and methods

Suicide data were extracted from the Swiss cause-of-death statistics, courtesy of the Federal Statistical Office in Neuchâtel. The data entered in the analyses cover the period 1998–2007. ICD-10 coding has been in use since 1995. Since 1998, an extra code (“X618”) shows assisted

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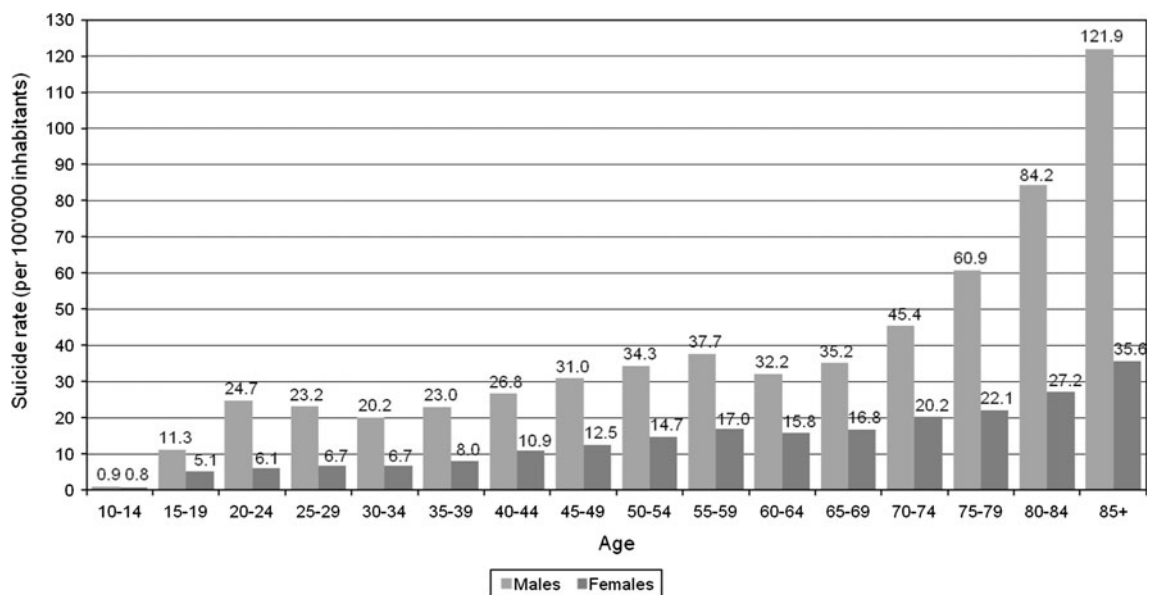


Fig. 1 Suicide rates by age and gender for the period 1998–2007

suicides permitting the differentiation of this cause of death in the analyses. We did not include the assisted suicides in our analyses, as this form of suicide differs in many ways from other suicides and accounted for only one suicide in the age group 0–19 years.

The registration rules generally assign the highest registration priority to violent causes of death, which results in suicide being registered as the main cause of death. As a violent cause of death, suicides are subject to routine investigation by both the police and forensic medicine; an autopsy is not performed on all suicides.

Using configural frequency analysis (CFA), we compared the distribution of the methods of suicide of all subjects aged 0–19 years (for males and females, respectively) with the distribution of the methods of suicide in the age group over 19 years. CFA can be used to screen cross-tabulations for cells (configurations) that contain significantly more cases (types) or fewer cases (antitypes) than expected by chance (i.e., assuming independency between the characteristics defining the cross-tabulation). In CFA, a significance test is applied in parallel for each configuration so there is a high risk of committing a type I error (i.e., detecting a type or antitype when the null hypothesis is true). To control for this alpha error inflation, we applied the Bonferroni-adjustment for the alpha-level.

Results

In the period between 1998 and 2007, the Swiss mortality statistics included 13,410 suicides: 9,281 (69.2%) males and

4,129 (30.8%) females. For further analyses, we excluded assisted suicides. After their exclusion, the respective figures were 12,226 suicides; 8,763 (71.7%) males and 3,463 (28.3%) females. During this period, 333 suicides were registered in the age group 0–19 years: 226 (67.9%) male and 107 (32.1%) female children and adolescents. The suicide rates by gender and age group are presented in Fig. 1.

The most important methods of suicide over all age groups were the use of firearms (34.6%) and hanging (28.7%) for males. The dominant methods in females were intoxication (25.9%), hanging (22.0%), and jumping from heights (18.1%). Table 1 shows the distribution of the methods of suicide with regard to sex and age groups (0–19 vs. >19 years). Note that there was no suicide in children less than 12 years of age.

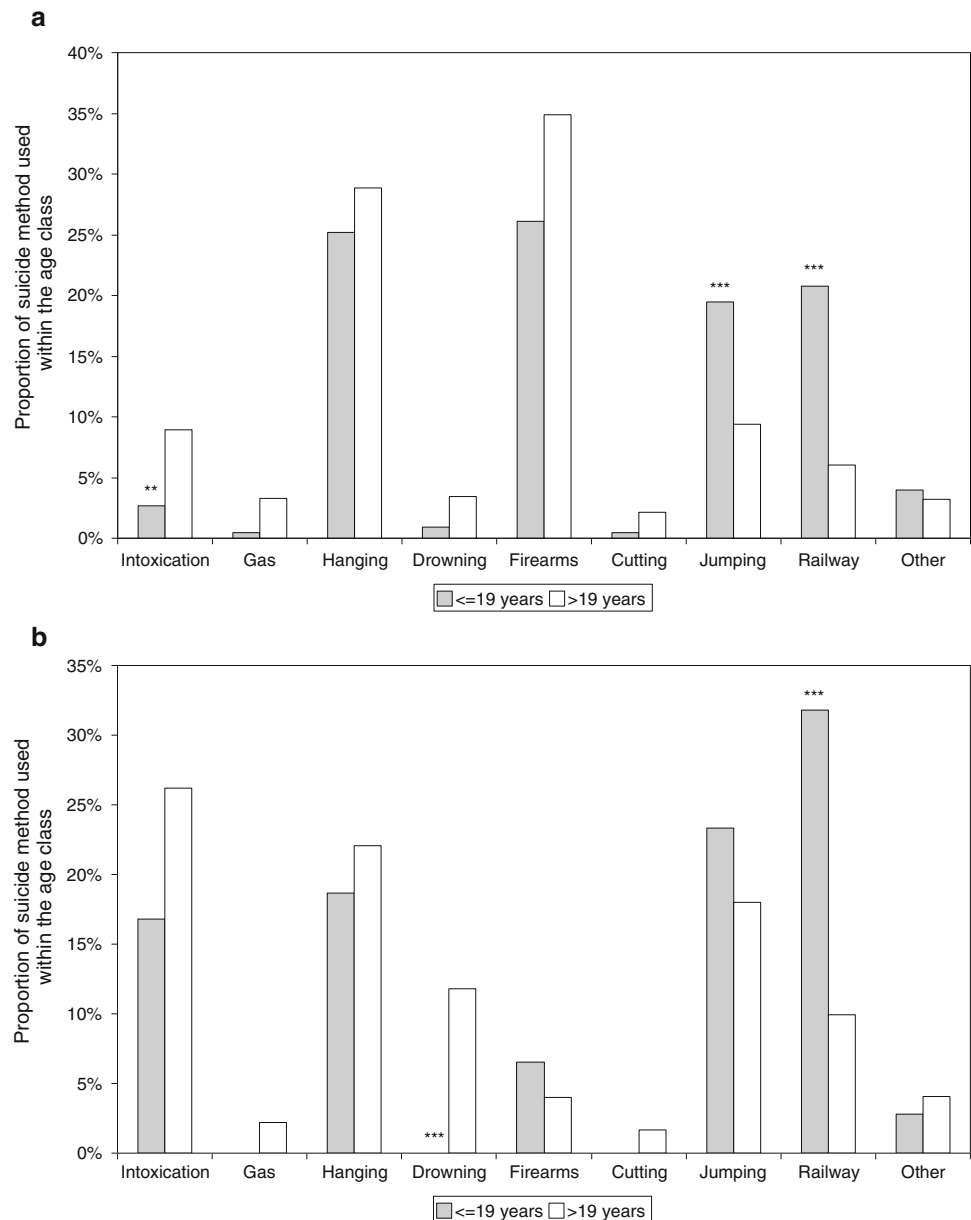
In the descriptive analyses, all suicides committed over a period of 10 years were differentiated by age groups (0–19 vs. >19 years), sex and the method of suicide (Fig. 2a, b). In the age group 0–19 years, the predominant methods in males were the use of firearms (26.1%), hanging (25.2%), railway-suicides (20.8%) and jumping from heights (19.5%). Compared to the methods of suicide used by males older than 19 years, it is notable that railway-suicides ($\chi^2 = 73.6$, $df = 1$, $P = 0.000$) and jumping from heights ($\chi^2 = 22.6$, $df = 1$, $P = 0.000$) were significantly over-represented in children and adolescents, whereas suicide by intoxication in this age group was significantly under-represented ($\chi^2 = 9.7$, $df = 1$, $P = 0.002$). Suicide by gas ($\chi^2 = 5.4$, $df = 1$, $P = 0.020$), by drowning ($\chi^2 = 4.1$, $df = 1$, $P = 0.044$) and by firearms ($\chi^2 = 4.7$, $df = 1$, $P = 0.030$) were also less frequent in children and

Table 1 Suicide methods by age and gender for the period 1998–2007

Method		All								
		Intoxication	Gas	Hanging	Drowning	Firearms	Cutting	Jumping	Railway	Other
Males										
0–19 years										
<i>n</i> (%)	6 (2.7%)	1 (0.4%)	57 (25.2%)	2 (0.9%)	59 (26.1%)	1 (0.4%)	44 (19.5%)	47 (20.8%)	9 (4.0%)	226 (100%)
χ^2	9.65	5.44	0.97	4.06	4.73	2.93	22.63	73.64	0.44	
<i>P</i>	0.0018	0.0196	0.3246	0.0439	0.0296	0.0869	0.0000	0.0000	0.5071	
>19 years										
<i>n</i> (%)	763 (8.9%)	282 (3.3%)	2,461 (28.8%)	290 (3.4%)	2,975 (34.8%)	182 (2.1%)	801 (9.4%)	512 (6.0%)	271 (3.2%)	8,537 (100%)
χ^2	0.26	0.14	0.03	0.11	0.13	0.08	0.60	1.95	0.01	
<i>P</i>	0.6101	0.7082	0.8624	0.7401	0.7184	0.7772	0.4385	0.1625	0.9203	
All males										
<i>n</i> (%)	769 (8.8%)	283 (3.2%)	2,518 (28.7%)	292 (3.3%)	3,034 (34.6%)	183 (2.1%)	845 (9.6%)	559 (6.4%)	280 (3.2%)	8,763 (100%)
Females										
0–19 years										
<i>n</i> (%)	18 (16.8%)	0	20 (18.7%)	0	7 (6.5%)	0	25 (23.4%)	34 (31.8%)	3 (2.8%)	107 (100%)
χ^2	3.42	2.29	0.52	12.27	1.56	1.70	1.61	45.04	0.41	
<i>P</i>	0.0644	0.1302	0.4708	0.0004	0.2116	0.1922	0.2044	0.0000	0.5219	
>19 years										
<i>n</i> (%)	880 (26.2%)	74 (2.2%)	741 (22.1%)	397 (11.8%)	135 (4.0%)	55 (1.6%)	603 (18.0%)	334 (10.0%)	137 (4.1%)	3,356 (100%)
χ^2	0.11	0.07	0.02	0.39	0.05	0.05	0.05	1.44	0.01	
<i>P</i>	0.7401	0.7913	0.8875	0.5322	0.8230	0.8230	0.8230	0.2301	0.9203	
All females										
<i>n</i> (%)	898 (25.9%)	74 (2.1%)	761 (22.0%)	397 (11.5%)	142 (4.1%)	55 (1.6%)	628 (18.1%)	368 (10.6%)	140 (4.0%)	3,463 (100%)

Figures in boldface indicate significant types or antitypes (cells) when applying Bonferroni correction within males and females, respectively ($\alpha = 0.05/18 = 0.0028$)

Fig. 2 a Suicide methods by age for the period 1998–2007 (males). ** $P < 0.01$, *** $P < 0.001$ (Bonferroni-corrected significances are indicated only). **b** Suicide methods by age for the period 1998–2007 (females). *** $P < 0.001$ (Bonferroni-corrected significances are indicated only)



adolescents than in adult males. However, after controlling for alpha error inflation (Bonferroni correction: $0.05/18 = 0.0028$) these differences were no longer of statistical significance. Although there was no significant difference between age groups concerning firearm suicides, it is noteworthy that firearms account for one in four suicides in male children and adolescents (Table 1).

In females aged 0–19 years, the predominant methods of suicide were railway-suicides (31.8%), jumping from heights (23.4%), hanging (18.7%) and intoxication (16.8%). Railway-suicides were significantly over-represented compared to females older than 19 years ($\chi^2 = 45.0$, $df = 1$, $P = 0.000$), whereas drowning was significantly less

frequent than expected by chance in females under 19 years ($\chi^2 = 12.3$, $df = 1$, $P = 0.000$) (Table 1).

Discussion

Methods of suicide

Restricting the access to the means of suicide is an important strategy in suicide prevention. This study examined the relative frequency of various methods of suicide used by Swiss children and adolescents (0–19 years) and compared it to methods of suicide used by adults (>19 years).

Although children do attempt suicide [12], over the 10-year period examined here, there were no completed suicides in children 0–12 years. Suicide remains a very rare event in the age group 12–14 years but it increases in frequency in later adolescence [13, 15].

Intoxication as a means of suicide is significantly less frequent in male children and adolescents than in male adults. In female children and adolescents, there seems to be a similar tendency ($P = 0.06$). This is quite remarkable as intoxication by drug overdoses is the most common method for attempted suicide, in particular in children [12] and adolescents [8, 20]. During the past decades, there have been successful efforts made in Europe to reduce the access to potentially toxic medical drugs (e.g. selective serotonin reuptake inhibitors SSRIs instead of tricyclic antidepressants TCA; distribution of smaller packages). For children and adolescents the access to potentially lethal drugs might be more difficult and they possibly lack sufficient knowledge of potentially toxic drugs and lethal doses.

The relatively high proportion of firearm suicides in male adolescents (~26%) compared with international data can to a large part be explained by the high availability of firearms in Switzerland. The higher the availability of firearms, the higher is the proportion of firearm suicides [1, 2]. In Switzerland and in the US, where the proportion of households owning firearms was highest (36 and 32%), the proportion of firearm suicides was also higher (27 and 57%) than in 18 other Western countries [1]. It can be hypothesized that in the age group 0–19 years the person who committed suicide was not usually the owner of the firearm. The availability of firearms in households seems to be a risk factor not only for the gun owner, but also for other family members [21]. Nevertheless, children and adolescents have less access to firearms and are not familiar with the handling of weapons; consequently, there is a trend to a lower proportion of firearm suicides in male adolescents compared with adults. To prevent firearm suicides, gun restriction by gun licensing laws obviously is a promising preventive approach. In the past years, the access to ammunition was restricted in Switzerland. Though army weapons are still stored at home, the ammunition is no longer kept in private households. This led to a decrease in firearm suicides in recent years.

Railway suicide seems to have a special attraction for children and adolescents as this method is clearly over-represented in both genders. Here, availability could also be an explanation. Switzerland has one of the best-developed railway networks of all European countries; railway lines are quickly accessible for almost anybody. In line with this, the proportion of railway suicides is higher in young Swiss people than in most European countries

(except for the Netherlands) [32]. This method is highly prone to imitation. Safeguarding hot spots (e.g. erecting barriers at railways near psychiatric hospitals) and the implementation of media guidelines can be preventive strategies [28, 30].

Jumping from heights is a relatively frequent means of suicide in Switzerland [24, 25]. Nearly every fifth female suicide happened by jumping from heights, with no clear difference between female adolescents and adults. In males, jumping from heights is less frequent than in females and accounts for about 10% of overall male suicides. Nevertheless, the high proportion of this method of suicide in young males (~20%) should be addressed. Bridges and other hot spot heights are suited to preventive interventions [24]. Efforts to safeguard some hot spots were successful [23]. For instance, after securing a bridge in the Canton of Zug (Switzerland), there have been no more suicides by jumping during the past 3 years. Before installing a protective wall and SOS telephones on that bridge, about three suicides happened per year. Interestingly, there seems to be no shift to other jumping sites or suicide methods (Walti H; personal communication).

Hanging was the method of suicide in second place in male, and in third place in female adolescents. There were no differences compared to the age group older than 19 years. Hanging, a highly lethal means, is one of the methods of suicide to which preventive strategies can hardly be applied. Unfortunately, the suicidal intention seems to be particularly strong and long lasting in those individuals who choose hanging as their means of suicide—after an unsuccessful suicide attempt by hanging, the risk of an upcoming completed suicide is highest of all suicide means [27].

Drowning as a means of suicide is almost irrelevant in the age group 0–19 years (only two cases). This method is used primarily by older people [31, 34]. Among young people, there was a decreasing trend in suicides by drowning over the past decades [15]. This could be explained by the introduction of compulsory swimming instruction in schools; drowning is probably not an appealing method to strong swimmers. In fact, this could be an example of a successful suicide preventive intervention, although the primary intention was the prevention of accidental, not intentional, drowning.

With the introduction of the catalytic converter, inhaling vehicle exhaust fumes as a means of suicide became much less lethal and almost obsolete in Switzerland [14]. Young people appear to ignore the existence of this method or perhaps it has simply gone out of fashion. Other gas intoxications are obsolete since the detoxification of domestic gas in Switzerland [16].

Cutting, the method in second place in parasuicide [20], is another method of suicide not relevant to adolescents.

Suicide by sharp objects is often associated with psychotic conditions and, therefore, more prevalent in older age groups.

Compared to the European average, firearm suicides, jumping from heights and railway suicides were shown to be more common amongst Swiss adolescents than in their European counterparts, whereas hanging is a method much less used by Swiss adolescents [32]. Firearm suicides, jumping from heights and railway suicides are all potentially well suited to preventive strategies.

Special aspects of suicide in children and adolescents

Although suicide is a comparatively rare event in children and adolescents, it is one of the leading causes of death and life years lost among them. When considering suicide prevention, there are characteristics of adolescent suicidal behaviour that are worth highlighting.

Whereas suicidal concerns (ideation, plans, and attempts) are common in adolescents [26], they are often of temporary nature in young people [5]. Unlike in adults [3, 11], mental disorders might play a less crucial role in adolescent suicidal behaviour. In young individuals impulsiveness and short term triggers such as relational conflicts [8] may often set off suicidal events when they are superimposed on long-term underlying reasons that account for the vulnerability for suicidal behaviour in stressful situations [8, 29]. Many young suicide attempters report that they spent only minutes between the decision and the actual attempt indicating a high degree of impulsiveness. As impulsive suicide attempters used more violent methods, such as firearms, hanging and jumping [29], Ohberg et al. [22] emphasized the importance of restricting access to highly lethal methods to prevent suicide in adolescents and young adults.

Many suicidal individuals have a preference for a specific method of suicide [27]. If there is limited access to a given means of suicide, it is unlikely that the person in a crisis will easily postpone the intention or shift to another method [7]. In addition, even in the worst case, if a suicidal person switches to another means because he or she has no access to a given method, there is still a chance that a less lethal method is chosen. In the better case, perhaps time can be saved and alternative strategies for coping with the crisis can be applied.

Children and adolescents might be more suggestible and more prone to imitating (“copy cat”). They might be more attracted by hot spots and more strongly influenced by media reports. The “Werther effect” is more prominent in young people. Imitation was shown to play an important role especially in railway suicides and in suicides by jumping from heights [28]. Here, the implementation of media guidelines can be a preventive strategy [30].

Limitations

The absolute number of suicides in the age group 0–19 years is relatively low. Thus, there is low statistical power bearing the risk of missing meaningful associations (beta-error). Furthermore, it would have been interesting to examine whether there are differences in the suicide methods used across the country. For example, the proportion of firearm suicides varies substantially between Swiss cantons (15–33%), and it has been shown to be positively related to the availability of firearms [2]. Rates of suicides by jumping also differ considerably between Swiss regions [24]. The relatively low number of suicides in the age group 0–19, however, impeded comparisons between suicide methods in young people on a sub-national level.

To a certain extent, suicide frequencies based on mortality statistics generally tend to under-estimate the real number of suicide deaths. Potential mis-reporting typically falls into categories such as “injuries undetermined whether accidentally or purposely inflicted”, “injuries due to drowning”, “injuries due to vehicle crashes”, and “poisonings” [9]. Such reporting bias presents a minor problem when making comparisons between gender and age groups as a large proportion of mis-reporting is probably independent of gender and age.

The choice of the methods of suicide depends on availability and is subject to cultural differences. To some extent, the use of methods of suicide in Switzerland differs from other European countries [32, 33] and the results of this study are not representative for all European countries. For instance, a recent study revealed lower rates of youth suicide by jumping and by railways in Finland [15]. However, specific divergencies may lend further insight into the relation between the availability of lethal methods, culture-specific issues and the methods of suicide used in different age groups.

Conclusion

Variations in the degree of availability have an important influence on the methods of suicide chosen by children and adolescents. The main methods of suicide in children and adolescents are, in males, the use of firearms, hanging, railway-suicides and jumping from heights and, in females, railway-suicides, jumping from heights, hanging and intoxication. Where suicide prevention is concerned, the use of firearms, railway suicides and jumping from heights must be addressed. Restricting the availability of firearms, safeguarding hot-spots and applying media guidelines are evidence-based preventive strategies.

Apart from these general public-health measures there should be specific health-care strategies that take into

account the special needs of young suicidal persons. Attention must be focused on the high prevalence of—albeit often transient—suicidal ideation in adolescents, the role of relational conflicts and the impact of impulsivity. There should be low-threshold services made available such as telephone and internet help lines that reflect the widespread use of modern communication platforms and social networks by adolescents.

Conflict of interest The authors declare that they have no conflict of interest.

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